Materials and Methods: Standard 3D IMRT treatment plans were created for 10 NSCLC patients with lymph node involvement based on the mid-ventilation phase with a prescribed dose of 66Gy/33F. A CTV margin of 1 cm was used around the lymph nodes and was adjusted in order to exclude bone tissue and larger blood vessels. Patient-specific PTV margins of 0.7-1.0 cm were calculated using a probabilistic margin formula and were applied to the CTV. Random day-to-day variations of the baseline shift between the primary tumour and the CTV-node were simulated by blurring the dose distribution in either the cranial-caudal (CC), left-right (LR) or anterior-posterior (AP) directions with a Gaussian error distribution. Furthermore, a systematic shift between the lymph node and the primary tumour was simulated by displacing the dose distribution relative to the delineated structures with both 0.25 cm and 0.50 cm. Sufficient dose coverage of the involved lymph node was defined as the minimum dose ($D_{98\%}$) of the CTV-node was larger than 95% of the prescribed dose for 90% of the patients.

Results: The figure shows the minimum dose of the CTV-node for 90% of the patients as a function of the random peak-to-peak variation in the CC direction for the different types of simulations. Dose coverage was sufficient for all data points above 95% of the prescribed dose, which is indicated by the dashed line in the figure. Table 1 summarises the acceptable random peak-to-peak variations in the CC, LR, and AP directions with 0 cm, 0.25 cm and 0.50 cm systematic shifts.

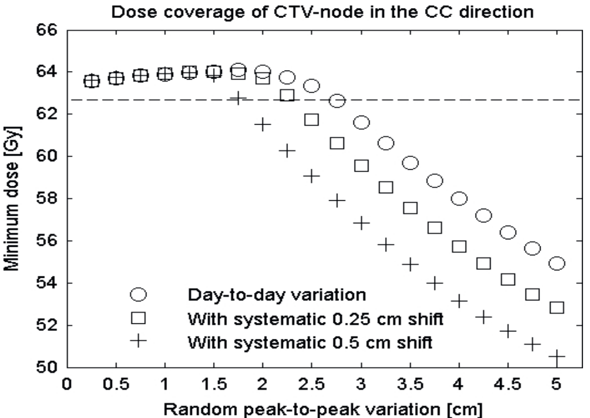

Table 1: Sizes of random peak-to-peak motions with dose coverage of the CTV-node to 90% of the patients

	Day-to-day variation only	With 0.25 cm systematic shift	With 0.50 cm systematic shift
CC	2.50 cm	2.25 cm	1.75 cm
LR	3.00 cm	3.25 cm	3.25 cm
AP	3.00 cm	2.75 cm	2.50 cm

Conclusions: Dose coverage of the CTV-node can be achieved with large random peak-to-peak variations between the primary tumour and CTV-node in treatments corrected for daily baseline shift of the primary tumour. With the introduction of a systematic shift during the treatment course the random peak-to-peak variation was only slightly reduced. However, large systematic shifts are undesirable and should justify a re-planning of the treatment.

PO-0850

Accuracy of online position verification in breast radiotherapy with two orthogonal kV fields

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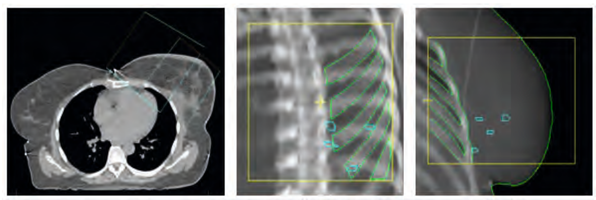
Purpose/Objective: 3D position verification in breast radiotherapy with kV-CBCT is very accurate but time-consuming, especially in gated breast radiotherapy. Due to the need for uniform position verification in non-gated and gated conformal breast radiotherapy, the accuracy of the patient position adjustment based on the online matching of two orthogonal kV fields was investigated.

Materials and Methods: Twenty breast cancer patients and 20 patients treated for breast cancer in combination with internal mammary-medial supraclavicular (IMMS) lymph node irradiation, i.e. locoregional breast treatment, were included in the study. Each treatment was performed on a Varian Clinac 2100C/D linear accelerator equipped with an amorphous-silicon EPID and an OBI system (Varian Medical Systems, Inc.). The patient positioning and isocenter shift were checked with online paired kV-kV matching using the ribs close to the isocenter. One of the orthogonal kV fields was parallel to one of the tangential field directions (see figure). Only translations were adjusted. The new patient position was verified during 5 fractions by MV imaging of both tangential breast fields and kV imaging of the MS-field. All images were matched in Offline Review (Varian Medical Systems, Inc.) using bony anatomy. The differences for each tangential field were reported as ΔCLD (Central-Lung-Distance, i.e. the distance between the deep field edge and the interior chest wall at field central axis), and ΔC(ranio)C(audal). The differences for the MS-field were reported as ΔVrt, i.e. ΔVertical, ΔCC and ΔLat(eral). The range of the patient mean errors, the percentage of the patient population with an absolute value of the mean error larger than 2mm, the population mean, population systematic error and population random error were reported.

Results: For breast cancer treatment with and without IMMS irradiation, a mean CLD error ranging from -1mm to 2mm and from -1mm to 3mm, respectively, was found. Only 5% of the breast cancer patients had a mean ΔCLD > 2mm. The patient mean ΔCC ranged from -3mm to 3mm and from 0mm to 3mm for the breast treatments and the locoregional breast treatments, respectively. For 10% of the patients, the mean ΔCC was larger than 2mm, irrespective of the treatment. None of the population systematic errors were larger than 1mm and none of the population random errors were larger than 2mm, irrespective of the patient group (see table). The population systematic and random errors measured in the MS-field were smaller than 1mm for all three directions (see table).



		Tangential 1 ΔCLD (mm)	Tangential 1 ΔCC (mm)	Tangential 2 ΔCLD (mm)	Tangential 2 ΔCC (mm)	MS-field ΔVrt (mm)	MS-field ΔCC (mm)	MS-field ΔLat (mm)
Breast radiotherapy	[Δ_{Min};Δ_{Max}]	[-1;3]	[-3;3]	[-2;1]	[-2;2]	-	-	-
	μ	0.6	0.2	-0.2	0.2	-	-	-
	Σ_{syst}	1	1	1	1	-	-	-
	σ_{syst}	2	2	1	2	-	-	-
	|Δ|>2mm	5%	10%	-	-	-	-	-
Locoregional breast radiotherapy	[Δ_{Min};Δ_{Max}]	[-1;2]	[0;3]	[-2;2]	[-1;4]	[-0.2;0.2]	[-0.2;-1.2]	[-2;1.2]
	μ	0.4	0.8	-0.3	0.6	0.02	0.2	-0.3
	Σ_{syst}	0.8	0.9	1	1	0.09	0.4	0.7
	σ_{syst}	1	2	2	2	0.2	1	0.9
	|Δ|>2mm	0%	10%	-	-	-	-	-

Conclusions: The new position verification protocol is appropriate for accurate, uniform and quick 3D position verification in non-gated (locoregional) breast radiotherapy and easily extendible to gated breast radiotherapy. An important property of the protocol is the low imaging dose to both the target volume and the healthy tissue thanks to the combination of the kV imaging and the field orientation.

PO-0851

Dosimetric effects of small setup uncertainties for various intensity modulated proton therapy delivery methods

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Purpose/Objective: Uncertainties in patient positioning are a crucial issue to be considered when treating patients with particles. In this study we aim to quantify the effect of small patient misalignment for different proton dose delivery techniques.

Materials and Methods: We have investigatedthree different delivery techniques: 3D spot-scanning (3DSS), distal edge tracking(DET) and